Study Guide for A-SO Certification Rev.10/03

Please refer to the "April 2004 Exam Book List" for a complete list of recommended study materials.

General

1) What is the detrimental effect of sediment in streams?
Answer:

Destroys aquatic habitat
Creates turbidity that detracts from the beneficial use of the water
Increases water treatment cost

2) What damage will occur if turbidity increases in a stream?
Answer:

Turbidity degrades the usefulness of water
Turbidity increases the cost of water treatment
Turbidity decreases the amount of sunlight reaching aquatic plants, thereby decreasing oxygen available to fish.

3) Why is the use of ammonia for acid neutralization undesirable from a water quality viewpoint?
Answer:

Ammonia is toxic to fish and also depletes oxygen in the stream.

4) Sediment transportation and deposition is influenced by the flow characteristics of the water course and the nature of the particles transported. How are the flow characteristics determined?
Answer:

By the velocity and turbulence of the moving water.

5) What are generally the major sources of sediment from surface mine operations?
Answer:

They are disturbed areas such as those with soil removed, and those on which active operation is in progress.

6) What does the phrase "mine drainage" mean as it pertains to NPDES permits?
Answer:

It means any drainage, and any water pumped or siphoned, from the active mining area or a post-mining area.

7) What is "reclamation"?
Answer:

The process of converting mined land to its former state and/or other productive uses.

8) What does the phrase "1-year, 24-hour precipation event" mean?
Answer:

It means the maximum 24-hour precipitation event with a probable recurrence interval of once a year.

Sedimentation Basins

1) What are the benefits of decreasing the velocity (and turbulence) of the moving water in sediment control?

Answer:

Decreased velocity will reduce the ability of the water to transport sediment and reduce the ability of the run-off to detach soil particles.

2) What are “sediment traps”?

Answer:

They are small temporary structures used at various points of disturbed areas to detain run-off for a short period of time and trap heavier sediment particles.

3) There are two types of sediment ponds (basins). What are they?

Answer:

The dry basin and the wet basin.

4) What is a “dry basin” as it pertains to sediment control?

Answer:

A basin used to trap sediment in an off-stream location that is dry most of the time.

5) What is a “wet sediment basin,” as it pertains to sediment control?

Answer:

It is a structure created to impound water for the purpose of settling sediment in the run-off.

6) What is meant by an “overflow rate”?

Answer:

It is defined as the ratio of pond discharge to the surface area of the pond.

7) What will happen to the overflow rate if the flow rate of water to a basin is unchanged but the area of the basin is increased?

Answer:

The overflow will decrease and smaller particles will be settled out.

8) What factors could disturb efficient settling of particles in a basin?

Answer:

They include:

- Short circuiting
- Bottom scouring
- Turbulence
- Non-uniform deposition
- Entrance and exit effects
- Irregular shape of the suspended material.

9) What is the function of baffles in a pond?

Answer:

To increase uniformity of detention time and to provide full utilization of the pond (or reduce short circuiting).

10) What will the effect of partitioning a pond into a number of chambers and allowing water to overflow from each chamber along the entire width be?
Answer:

This can improve pond performance in retaining suspended solids, because it will reduce short circuiting.

11) Dye tests on experimental rectangular sediment ponds have shown that maximum efficiency can be expected at a certain length-to-width ratio. What is the optimum ratio?
Answer:

Length to width = 5:1.

12) Construction of an energy dissipator in the sediment pond entrance can produce a reduction in _____ _____.
Answer:

Influent velocity.

13) Modifying the inflow to the sediment basin so that the flow enters along the entire _____ of the basin, as much as possible, can increase the suspended solids removal efficiency of the basin.
Answer:

Width.

14) Wrapping a plastic filter cloth around a standard <u>perforated</u> riser can increase the retention of _____ _____ material.
Answer:

Fine-grained.

15) Why is it preferred to have a very wide overflow weir instead of a standard riser pipe for the solids removal efficiency of a sediment pond?
Answer:

It will reduce the outflow velocity of the water.

16) Two or more ponds used in series, instead of one large basin covering the same area, have been shown to increase the removal efficiency. One reason for this improvement is _____.
Answer:

Reduction of short circuiting.

17) Short circuiting is undesirable in a sediment basin. What is short circuiting?
Answer:

An hydraulic condition occurring in part of a basin where the time of travel is less than the theoretical flow-through time.

18) All sediment containment structures require an inspection after major _____.
Answer:

Rainstorms.

19) What is the most important maintenance need for a sediment containment basin?
Answer:

The removal of accumulated sediment.

20) A rule of thumb that can be used to determine when to clean out a sediment basin is:
Answer:

When a sediment basin has reached 50% of its sediment storage capacity or six months after the mining operation was started.)

21) Small quantities of sediment from a sediment basin may be disposed of by:
Answer:

Burial in the active pit or disposal by dewatering and covering with soil and vegetation.

22) Large quantities of sediment from a sediment basin may be disposed of by?
Answer:

Special provisions should be made either to bury it in an area designated for that purpose, or to stockpile, dewater, spread, adequately cover, soil stabilized, and vegetate it properly.

23) Accumulated sediment, that will be left in place after mining is completed, should be:
Answer:

Spread, covered, topsoiled, and vegetated , or stabilized by mechanical means, to prevent it from eroding back into the stream.

24) Once surface mining is complete, what should be done with an earth bank built across a natural drainage way?
Answer:

The embankment and all accumulated sediment should be removed to a predetermined area within the mine property and the area where the embankment was soiled, stabilized, and vegetated properly.

25) What is a “check dam”?
Answer:

It is a small dam constructed in a gully or other small water course to decrease the stream flow velocity, minimize channel scour and promote deposition of sediment.

26) What is “rill” erosion?
Answer:

An erosion process in which numerous small channels only several inches deep are formed. It occurs mainly on recently cultivated soils.

27) What is “grubbing”?
Answer:

The operation of removing stumps and roots.

28) What is “chemical neutralization” in mining operation?
Answer:

It is the process of adding an alkaline compound, such as lime or sodium hydroxide, to an acidic water in order to raise the pH and overcome an acidic condition.

29) What equipment can be used to remove suspended solids in process wastewater?
Answer:

Cyclones, sloped-plated clarifiers, flocculation tanks, and thickeners.

30) One of the purposes of an effluent structure from a settling pond or a tank is to control exit velocity. What is the potential adverse effect of high exit velocity?
Answer:

Scouring, turbulence, and short circuiting.

31) Inlet and outlet design is very critical to good pond operation regardless of the size or shape of the pond. Two main objectives in designing inlets are:
Answer:

To reduce the influent velocity and
To allow the flow to spread across the width of the pond.

32) If a pump is used to remove effluent from a settling basin, it is desirable to have a separate pumping pond. What are the purposes of a pumping pond?
Answer:

By having a separate pumping pond (or pool) following a main settling pond, it will prevent turbulence, scouring and short-circuiting in the main pond.

33) What are the typical maintenance operations of settling pond?
Answer:

The pond must be cleaned on a definite schedule to prevent the pond from being completely filled with sediment.
The slope on banks of the pond must be protected and maintained.
Pipes, weirs, and structures should be checked regularly.
Solids removed from the pond should be placed in a disposal area so that they do not wash back into the pond.

34) A settling basin has the following dimensions: 200 feet long 50 feet wide and six feet average depth. What is the pond volume in million gallons?

a) pond volume = 200’ x 50’ x 6’ = 60.000 cf

$$60{,}000 \text{ cf} \times 7.48 \frac{\text{gal}}{\text{cu ft}} \times \frac{1\text{M}}{1{,}000{,}000} = 0.45 \text{ million gallons}$$

35) A settling basin covers five acres and is seven feet deep. How many cubic feet will it hold?
a)

$$\text{volume} = 5 \text{ acre} \times 43{,}560 \frac{\text{sq. feet}}{\text{acre}} \times 7 \text{ feet} = 1{,}524{,}600 \text{ cubic feet}$$

36) A rectangular concrete channel has a cross sectional area of 4.5 square feet. By use of a portable flow meter, it was determined that the average flow velocity was 0.6 feet per second. What was the flow rate in million gallons per day?

Flow rate = 4.5 sq. feet x 0.6 feet/sec = 2.7 cubic feet/sec

= 2.7 cf/sec x 60 sec/min x 1,440 min/day = 233,280 cf/day

= 233.280 cf/day x 7.48 gal/cf x $\frac{\text{million gal}}{1{,}000{,}000 \text{ gal.}}$ = 1.74 million gal/day

37) I changed the force main pipe size from 4" PVC to 6" PVC. If they are flowing full at the same velocity, what would be the increase in the flow rate can I expect?
Answer:

Since the pipe diameter was increased 1.5 times, the cross sectional area of the pipe was increased 2.25 times (1.5 x 1.5), and if the velocity remains the same, the flow rate increased by 2.25 times.

38) An 8-inch pipe is flowing full at a velocity of 2.0 feet/sec. What is the flow rate in GPM?
a)

Area of pipe = $\left(\frac{8}{12}\right)^2 \times \frac{3.14}{4}$ = 0.35sf

Flow rate = 0.35 sf x 2.0 feet/sec x 60 sec/min x 7.48 gal/cf = 314 gal/min

Neutralization of Acidic Wastewater

1) What does the phrase "acid mine drainage" mean as it pertains to the NPDES permit?
Answer:

It is defined as mine drainage which, before any treatment, either has pH of less than 6.0 or a total iron concentration of equal to or greater than 10mg/L.

2) What does the phrase "alkaline mine drainage" means as it pertains to the NPDES permit?
Answer:

It is defined as mine drainage which, before any treatment, has a pH equal to or greater than 6.0 and a total iron concentration of less than 10 mg/L.

3) What is pH?
Answer:

It is an expression of hydrogen ion concentration of water and is a measure of acidity or alkalinity of water. The acceptable pH range in the NPDES permit is 6 to 9. If the pH is above 9.0 it is too alkaline for aquatic life and for recreational use of a stream.

4) Why is the drainage from a coal mine normally acidic?
Answer:

Sulfurous compounds in coal and other toxic overburden react with atmospheric oxygen and produce compounds which make water acidic when dissolved.

5) What are some of the problems with acidic water?
Answer:

It interferes with growth and propagation of aquatic life. Low pH (acidic) water increases corrosive action on iron, steel, and concrete. It also affects the taste of water when it is used for drinking.

6) What is the normal method of raising the pH of acid mine wastewater?
Answer:

The most common method is chemical neutralization by use of sodium hydroxide, soda ash, or lime.

7) What are the items one should consider when using chemicals for neutralization of acidic wastewater?
Answer:

One should be careful in choosing the proper dosage, the method of chemical feeding and the mixing of chemical with the water. Many serious injuries have occurred while treating acidic wastewater, usually to the eyes. Therefore, proper safety precaution should be provided.

8) What is the practical way to choose the proper chemical dosage for neutralization of acidic waste?
Answer:

Run a bench test on small volume of the waste to be treated. Find the proper amount of chemical for that volume. Then calculate the amount of chemical needed for the entire volume of pond water.

9) The operator determined it takes 20 grams of lime for one gallon of water to raise the pH of acid mine waste from 5.2 to 6.5. How many tons of lime will be needed to raise the pH to 6.5 if the total volume of pond water is estimated at two million gallons?
Answer:

a) It will require 44.1 tons of lime. The calculation is:

$$20 \frac{\text{grams}}{\text{gal}} \times (2 \times 10^6)\ \text{gal} \times \frac{1\text{b.}}{453.6\ \text{grams}} \times \frac{\text{ton}}{2000\ \text{lbs}}$$

$$= 44.1\ \text{tons}$$

Oil-Water Separation

1) What is “oil & grease”?
Answer:

“Oil and grease” is defined as any material soluble in n-Hexane solvent. This includes biological liquids (animal fat) and mineral hydrocarbons (gasoline, diesel oil, lubricants).

2) What types of industries produce wastewater containing “oil & grease”?
Answer:

Petroleum (refining and storage) metal (grinding), food (animal processing) and textile (scouring natural fiber).

3) What is primary treatment of oily waste?
Answer:

This is the process of gravity separation of floatable oil and grease from water and emulsified oily material.

4) What is the secondary treatment of oily wastewater?
Answer:

Treatment in which emulsified oil is treated and separated from water.

5) What is the most common device for primary treatment of oily wastewater?
Answer:

Gravity type separators are the most common devices employed in oily waste treatment.

6) What is an oil-water emulsion?
Answer:

A mixture of oil and water in which oil is held in suspension in water and does not easily float to surface.

7) What affects the efficiency of a gravity oil separator?
Answer:

It depends on proper hydraulic design and the detention time of the liquid in the tank.

8) What is an "API" separator?
Answer:

API stands for American Petroleum Institute. The equipment is a common device used to separate floatable oil from water.

9) What is the expected removal efficiency of floatable oil from a gravity (API) separator?
Answer:

For flotable oil, 60 – 99% removal can be expected.

10) What are considered grease and oils?
Answer:

Hydrocarbons
Fatty acids
Soaps
Fats
Waxes
Oils
Any other materials by n-Hexana from an acidified sample.

11) What kinds of problems can "oil and grease" cause for a biological wastewater treatment plant?
Answer:

They are not easily decomposed by bacteria, and tend to coat surfaces. The particles of oil and grease interfere with biological action and cause maintenance problems. In addition, oil and grease may increase the demand for oxygen.

12) What is the objection of allowing oil and grease discharged into streams?
Answer:

They can interfere with natural re-aeration.
They are toxic to certain species of fish and aquatic life.
They can reaste a fire hazard, when present on the water surface in sufficient amounts.
They can destroy vegetation along the shore line.
They can render boiler-feed and cooling water unusable.
They can impact odor and taste of drinking water.
They can create unsightly film on the surface of water.

Pumps & Maintenance

1) Where would you find information on when to lubricate a pump?
Answer:

Pumps should be lubricated in accordance with the manufacturer's recommendations.

2) What problems can develop if too much grease is used in lubricating an electric motor?
Answer:

It may cause bearing problems or damage the windings.

3) Why should a pump with a mechanical seal never run dry?
Answer:

A pump with a mechanical seal (or any other seal) should never run dry because water is required for seal lubrication.

4) What factors influence the rate of brush wear in a electrical motor?
Answer:

The rate of brush wear varies with the brush pressure. At light pressures, electrical wear dominant because the brush can jump off the rings, sparking occurs, and the filming action on the ring becomes erratic. At higher pressures, mechanical wear is dominant because of high friction losses, needless heating and abrasion.

5) What should you check if a pump will not start?
Answer:

If a pump will not start, check for blown fuses or tripped circuit breakers and then determine the cause. Also check for a loose connection, or thermal unit.

6) What would you check if the flow rate from a pump is lower than expected?
Answer:

You should check for something causing the reduced rate of discharge, such as pumping air, motor malfunction, plugged lines or valves, restricted suction, impeller problems, etc.

7) Under what conditions might a centrifugal pump be started against a closed discharge valve?
Answer:

Normally a centrifugal pump should be started after the discharge valve is opened. Exceptions are treatment processes or piping systems with vacuums or pressures that cannot be dropped or allowed to fluctuate greatly while an alternate pump is put on line.

8) What should be done before stopping an operating pump?
Answer:

Before stopping an operating pump:
Start another pump (if needed); and
Inspect the operating pump for developing problems, required adjustments, and problem conditions.

9) What could cause a pump shaft or motor to spin backward?
Answer:

A pump shaft or motor will spin backward if wastewater being pumped flows back through the pump when the pump is shut off. This will occur if there is a faulty check valve or foot valve in the system.

10) Why should the position (open or closed) of all valves be checked before starting the pump?
Answer:

The position of all valves should be checked before starting a pump to ensure that the wastewater being pumped will go where intended and to insure an open valve on discharge line.

11) What is the most important rule regarding the operation of a positive displacement pump?
Answer:

The most important rule regarding the operation of positive displacement pumps is to NEVER start the pump against a closed discharge valve.

12) What could happen if a positive displacement pump is started against a closed discharge valve?
Answer:

If a positive displacement pump is started against a closed discharge valve, the pipe, valve or pump could rupture from the excessive pressure. The rupture will damage equipment and possibly seriously injure or kill someone standing nearby.

13) How can you tell if a new pump is delivering design flows and pressure?
Answer:

Measure the flows and pressures and compare them with the pump performance curve supplied by the manufacturer.

14) What is the most common maintenance problem associates with water-level float controls?
Answer:

Scum and debris interfere with their operation and must be removed from water-level float controls.

15) What is a cross connection?
Answer:

A cross connection is a connection between two piping systems where an undesirable water (water from water seal) could enter a domestic drinking water supply.

16) Is a slight water-seal leakage desirable for a pump with packing gland when it is running?
Answer:

Yes. A slight leakage is desirable when the pumps are running to keep the packing cool and in good condition.

17) What should be done to a pump before it is shut down for a long period of time, and why?
Answer:

Before a prolonged shut down, the pump should be drained to prevent damage from corrosion, sedimentation, and freezing. Also, the motor disconnect switch should be opened to disconnect the motor.

18) What should be checked if pump bearings are running hot?
Answer:

If pump bearings are running hot, check for under- or over-lubrication. If properly lubricated, check the alignment of the pump (or motor) and check for badly worn bearings.

19) What are some of the common causes of shear pin failure in reciprocating pumps?
Answer:

Shear pins commonly fail in reciprocating pumps because of (1) a solid object lodged under the piston, (2) a clogged discharge line, or (3) a stuck or wedged valve.

20) Why would you use a stethoscope to check an electric motor?
Answer:

To listen to an electric motor for whines, gratings or thate is uneven noise.

21) How would you clean belts on a belt drive system?
Answer:

Belts are cleaned with a rag moistened with a non-oil base solvent.

22) How can you determine if a chain in a chain-drive unit has the proper slack?
Answer:

The proper slack in a chain can be achieved when a slight sag or looseness is observed on the return run of the chain.

23) What maintenance is required on gate valves?
Answer:

The most common maintenance required on gate valves is oiling, tightening, or replacing the stem stuffing box packing.

24) What maintenance is required on sluice gates?
Answer:

The most common maintenance required on sluice gates is testing for proper operation, cleaning and painting, and adjusting for proper clearance.

25) How would you maintain a portable gas detector?
Answer:

To maintain a portable gas detector:
Be sure the battery is charged periodically, and
calibrate using known standard gas concentrations obtained from the detector manufacturer.

26) Why should inactive gate valves be operated periodically?
Answer:

To prevent sticking.

27) What methods are available for cleaning a plugged pipe?
Answer:

Plugged pipelines may be cleared by the use of pressure methods, cutting tools, high-velocity pressure units and as a last resort, dismantling the plugged section and removing the obstruction.

28) How would you clean a plugged pump?

Answer:

To clean a plugged pump, isolate the pump from the remainder of the plant by valving-off the plugged pump and tagging and locking-out the power supply to the pump. Remove the pump inspection plate and remove material causing blockage.

29) What is flow measurement?
Answer:

Flow measurement is the determination of the rate of flow past a certain point, such as the inlet to the head-works structure of a treatment plant. Flow is measured and recorded as a quantity (gallons or cubic feet) moving past a point during a specific time interval (seconds, minutes, hours, or days). Thus we obtain a flow rate or quantity in cu ft/sec or MGD.

30) What is the basic flow formula?
Answer:

Quantity = cross sectional Area X Velocity, or q = AxV.

31) If a flow meter does not read properly, what items should be checked as potential causes of error?
Answer:

Potential causes of flow meter errors include foreign objects fouling the system or the meter may not be installed in the intended location. (Liquids should flow smoothly through the meter and flow should not be changing directions, nor should waves be present on the liquid surface above the measuring device.) Also, check the primary sensor, transmitter, receiver, and power supply.

Wastewater Analysis

1) What is one milligram per liter (1.0 mg/1) equivalent to?
Answer:

One part per million (1.0 ppm)

2) What is the lowest value an analytical balance can normally measure?
Answer:

0.1 mg. or 0.0001g

3) What is the minimum pH allowed in the effluent as specified in the NPDES permit?
Answer:

pH 6.0

4) What is a neutral pH?
Answer:

pH 7.0

5) Where is the ideal location to collect samples to test for NPDES permit limits compliance?
Answer:

The location where the water leaves the treatment pond or facilities (outfall location).

6) I collected samples for total suspended solids. How long can I keep them and how?
Answer:

The samples can be kept seven days if refrigerated at 4° C

7) How long can I store an oil and grease sample and how should it be stored?
Answer:

It can be stored 28 days if the sample pH is lowered to less than 2.0 with sulfuric acid H_2SO_4 and stored at $4^{\bullet}$C

8) How long can a sample for iron analysis be stored and how should it be stored?
Answer:

It can be kept 6 months if the sample pH is lowered to less than 2.0 with nitric acid before storage.

9) How long can I hold a sample for pH analysis and how should I store it?
Answer:

You should run a pH test immediately after sampling. No storage is allowed since the pH may change during storage.

10) Other than testing for pH immediately, what is the next important item one should be aware of for measurement of pH?
Answer:

The pH meter needs to be calibrated before the measurement, using known pH standards.

11) How many pH standards should be used to calibrate a pH meter?
Answer:

Two pH standards should be used to bracket the anticipated sample pH. For example, if the sample pH is expected approximate 7.5, pH standards of 7.0 and 10.0 should be used to calibrate the pH meter-probe.

12) How long can I keep the pH standard solution?
Answer:

IDEM recommends replacing the pH standard solution after six months.

Formula Sheet for the Class I-SP & A-SO Exams

Revised 05/00

F001

Surface area of a pond, acres = $\frac{\text{Length, ft x width, ft}}{43560}$

F002

Volume of a pond, MG =

$$\frac{\text{(Surface area, sf + bottom area, sf)}}{2} \times \text{Depth, ft} \times 7.48 / 10^6$$

F003

BOD loading = Flow, mgd x BOD conc, mg/l x 8.34

F004

BOD removal efficiency, % =

$$\frac{\text{(Influent BOD, mg/l - effluent BOD, mg/l)}}{\text{Influent BOD, mg/l}} \times 100$$

F005

Organic loading, lbs BOD/day/acre = $\frac{\text{Flow, mgd x Influent BOD, mg/l x 8.34}}{\text{Pond surface area, acre}}$

F006

Population loading, person/acre = $\frac{\text{Population served}}{\text{Pond surface area, acre}}$

F007

Population equivalent, persons/day = $\frac{\text{BOD load, lbs/day}}{0.17}$

F008

Theoretical detention time of a pond, days = $\frac{\text{Volume of the pond, MG}}{\text{Flow rate, MGD}}$

F009

Detention time, hrs = $\frac{\text{Volume, MG}}{\text{Flow rate, MGD}} \times 24$ hrs/day

F010

Flow rate, MGD = Flow rate, gpm x $\frac{1440}{1{,}000{,}000}$

F011

Removal efficiency, % = $\frac{\text{(Influent conc - effluent conc)}}{\text{Influent conc}} \times 100\%$

F012

Solids loading, lbs/day = (Flow, MGD) x (influent TSS, mg/l) x 8.34

F013
Required effluent BOD conc, mg/l =

(Influent BOD, mg/l) x [(100 - required removal, %) / 100]

F014
Volume of a circular tank, cf = 0.785 x (diameter, ft)^2 x (depth, ft)

F015
Sludge volume index, ml/g = $\frac{\text{(Settleable solids, \%)}}{\text{MLSS mg/L}}$ x 10,000

F016
Average flow rate, MGD = $\frac{\text{(Final flow, MG) - (initial flow, MG)}}{\text{Time elapsed, days}}$

F017
BOD loading, lbs/day = (Flow rate, mgd) x (BOD, mg/l) x 8.34

F018
TSS removal efficiency, % = $\frac{\text{(Influent TSS - effluent TSS)}}{\text{Influent TSS}}$ x 100%

F019
Sludge age, days = $\frac{\text{MLSS in aeration tank, lbs}}{\text{Primary effluent SS, lbs/day}}$

F020
Volume of sample needed for a BOD test bottle, ml =

$$\frac{1200}{\text{Estimated BOD of the sample, mg/l}}$$

F021
BOD, mg/l =

$$\frac{\text{(Initial D.O., mg/l - final D.O., mg/l) x 300 ml}}{\text{Sample volume, ml}}$$

F022
Chlorine feed rate, lbs/day = (Flow, mgd) x (dosage, mg/l) x 8.34

F023
TSS test results, mg/l = $\frac{\text{Net dry weight, mg}}{\text{Sample volume, ml}}$ x 1000

F024
HTH feed rate, lbs/day = $\frac{\text{Chlorine required, lbs/day}}{\text{Lbs of chlorine in 1 lb of HTH}}$ *(HTH = High Test Hypochlorite)*